Journal of the Society of Arts.

FRIDAY, FEBRUARY 8, 1861.

DISTRICT MUSEUMS AND GALLERIES OF SCIENCE AND ART.

Upon the recommendation of the Committee to which this question was referred, the Council have passed the following resolutions:—

1. That the Society of Arts will promote the establishment and improvement of District Museums and Galleries throughout the United Kingdom, where objects of art and science may be exhibited, at times and under regulations which shall afford to all classes of the people the greatest advantages.

2. That the course of action of the Society shall be, to endeavour to bring District Museums into connection with this Society, the British Museum, the National Gallery, the South Kensington Museum, Kew Gardens, and other national institutions, and with private Societies, such as the Royal Horticultural, the Botanical, Zoological, Chemical, and Microscopical, with the view of establishing a systematic circulation of objects among District Museums; to endeavour likewise to promote contributions from public bodies and private individuals for the same purpose; to hold conferences from time to time when the subject may be discussed; to seek the assistance of Parliament when necessary; and generally to assist in promoting the objects in view.

3. That a General Committee be appointed to promote these objects, to consist of the Council of the Society, the representatives of all Institutions in Union and the promoters of district museums and galleries, with power to add to their number, and to appoint the necessary sub-committees.

4. That a General Meeting shall be held at the Society's Rooms, to which influential persons desirous of promoting the proposed objects shall be invited.

NINTH ORDINARY MEETING.

WEDNESDAY, FEBRUARY 6, 1861.

The Ninth Ordinary Meeting of the One Hundred and Seventh Session, was held on Wednesday, the 6th inst., Sir Thomas Phillips, Chairman of the Council, in the chair.

The following gentlemen were proposed for election as members of the Society:—

Dixon, Thomas	Millgarth Mill, Dyer-street, Leeds.
Hughes, Richard Hugh	96, Hatton-garden, E.C.
Leach, George	Britannia Mills, Leeds.
Martin, John	Killyleagh Mills, Co. Down, and 29, Ann-street, Belfast.
Rein, Frederick Charles	108, Strand, W.C.
Reynolds, Wm. G.	20, Stratford-place, Camden-square, N.W.

The following candidates were balloted for and duly elected members of the Society:—

Brown, John	Rose-hill, Chesterfield.
Burzorjee, Dr.	Northwick-lodge, St. John's-wood-road, N.W.
Crockford, Joshua	212, Euston-road, N.W.
Irvine, Robert	Black Hurlet, near Glasgow.
Scott, Sir Francis E., Bart.	Great Barr Hall, near Birmingham.
Tennant, Thomas M...	Newington Works, Edinburgh.
Walter, William Thos.	19, Long-acre, W.C.
Wilkinson, John	St. Helen's Mills, Leeds.
Wilson, George, jun....	West Hurlet, near Glasgow.

The following Institution has been taken into Union since the last announcement:—

Farnham, Young Men's Association.

The Paper read was—

ON THE PRESENT CONDITION OF THE WATER SUPPLY OF LONDON.

BY GEORGE R. BURNELL, C.E., F.G.S., F.S.A.

A few years since public attention was called, in a very prominent manner, to the numerous questions connected with the quality and the mode of distribution of water in the metropolis, and a very expensive parliamentary contest was waged between the advocates of the existing companies on the one side, and the General Board of Health on the other, which for a time clothed the whole subject with interest. After the excitement of the contest had passed away, the public interest seemed to have subsided; and, at the present day, the London population is contented to enjoy the advantages of the water supply it possesses, without much inquiry into the means and agencies employed in securing that blessing. Nevertheless the subject is one of sufficient importance to merit an occasional review; and as some very able persons connected with the administration of the laws affecting the public health have felt called upon to make what may be considered to be accusations against the quality of the London water supply, it has seemed to me desirable to bring about, if possible, an open discussion as to the merits and demerits of the present water supply, and as to the feasibility of some of the schemes proposed to remedy its defects. In some cases the operations of the Water Works Companies, subsequently to the passing of the Act of 1852, have also raised questions of the highest interest with respect to the subterranean geology of London, which I think merit more attention than they have yet received, and it will be my object briefly to allude to the conclusions fairly to be drawn from the facts observed with respect to them.

London, as you must all know, is built in the centre of a large basin of the tertiary formations composed mainly of stiff blue clays, underlying occasional patches of sands and gravels, and consisting at its base of permeable sand and mottled clays. The basement beds rest upon a depressed surface of chalk; and if, for the present, we limit our survey to the superficial geology, we find that around the lower margin of the chalk the subcretaceous formations outcrop in the valley of the Thames, to be succeeded by the oolites, and that none of the affluents of that river flow from any of the strata older than the oolites. All these formations, it is important to observe, are of more or less a moveable character, and their materials can easily be disturbed by heavy rains; moreover, nearly the whole of the surface of the vallies of the Thames and of its affluents is under cultivation, and is therefore the more susceptible of such disturbing actions. Lechlade, the first point where the navigation of the small head streams of the Thames commences, is situated at about 146 miles from London, and at an elevation of 258 feet above low water-mark of London-bridge. From thence the river, called in this part of its course the Isis, receives the Evenlode and the Charwell, flowing from the oolite and lias groups; then below Oxford it receives the Thame, also from the oolite and Oxford clay; the Windrush and

the Ock, from the chalk, or from the subcretaceous deposits; at Reading it receives the Kennet from the chalk; at Maidenhead, the Loddon, from the London clay; at Staines, the Colne, from the chalk; at Ham, the Wey, from the green sand under the chalk and the chalk itself; and shortly beyond the junction of the Mole, the tide is shut out by means of the Teddington locks. There are a few insignificant streams supplied to the Thames by the Bagshot sands, and, as we have seen, a few streams are derived from the lower green sands; but nearly all the affluents and the main stream are supplied by the formations which are likely to communicate to their waters the bicarbonate of lime; and from their high state of cultivation, and the number of inhabitants on their banks, it is fair to suppose that they also contain a rather large portion of organic matter. These remarks might be extended to the waters of the Lea and of the Ravensbourne, for they are both fed principally from the chalk springs of their respective vallies, and from the surface drainage of their water sheds, which are, as in the case of the valley of the Thames, highly cultivated. The only geological formations of a nature to supply pure, soft waters, in sufficient quantities for the consumption and the waste of a town like London, are situated at a very great distance from it. The Bala Lake, to which it has been proposed to resort, is, in fact, situated at about 170 miles, as the crow flies; nor are there any large bodies of water of a similar character to it to be met with nearer the metropolis, nor are any of the primary or plutonic rocks to be found within a reasonable distance.

In addition to the sources of water supply provided by the river and its affluents, the inhabitants of London were able formerly to derive a large quantity of water from shallow wells, sunk in the superficial gravels, or from deep wells sunk into the sand beds of the London clay, or into the subjacent chalk. For all municipal purposes, the wells in the gravel have long since become useless, and, both on the score of the quantity and of the quality of their waters, they may be here passed over, especially as the recent inquiries with respect to the effect of their waters upon the diffusion of the cholera, have raised so strong a feeling against their use, that no one would dare now to recommend those waters for any other purpose than for filling such pieces of ornamental water as the Serpentine, or St. James's-park. The deep wells in the basement bed still yield large quantities of water in some parts of London, and they are of great local value to manufacturers, but in other parts of the hydrographical basin of the metropolis, in consequence of the existence of a series of upheavals and displacements, the supply to the underground beds is so intercepted, and, at the same time, so great is the demand upon them, that, even in the most favourable places, they are gradually becoming exhausted. In the works of Messrs. Prestwich, Mylne, Braithwaite, Clutterbuck. &c., will be found a great mass of information on the subject of the gradual exhaustion of the subterranean water-bearing strata of London; and the permanent depression of the water-level in them has actually become an evil of serious practical magnitude to the factories which rely on this source of supply. It seems, however, that as much as 20 millions gallons per day are still drawn from the various wells about London, but now principally from the chalk. After the incessant rains we have had for the last eighteen months, it is possible that the level of the water in these wells may have risen, but the first drought will cause it again to fall, and every improvement which takes place in the land drainage of the exposed surfaces of the water-bearing strata, must tend to increase the exhaustion of their lower basin.

Although the exhaustion of the chalk, and of the basement bed of the London clay, has been thus markedly ascertained, it is curious that the Kent Waterworks Company should lately have succeeded in bringing to the surface a very large quantity of water by means of some wells sunk in the valley of the Ravensbourne, just before it falls into the Thames, and in the chalk itself. The yield of these wells is sufficiently great to enable the company to dispense almost entirely with its supplies from the Ravensbourne, and the water is bright, clear, and singularly wholesome and pleasant. It seems to me that the explanation of this anomalous flow of water is to be accounted for by the interference with the flow of the subterranean currents in the lower beds of the chalk—firstly, by the great line of fault which has given rise to the valleys of the Lea and of the Ravensbourne on the respective sides of the Thames; and, secondly, by the upheaval, in an east and west direction, which is known to exist between Windsor, Brentford, Deptford, Shooter's-hill, Grays, and the extreme north-westerly point of the embouchure of the Medway. In all probability, also, the same upheaval has thrown to the surface the spring which has lately been shown to exist on the north bank of the Thames, opposite to Gravesend; and I should be much disposed to believe that for many years to come large quantities of water would be obtainable from both the wells of the Kent Waterworks Company and from the newly-discovered spring, without producing any sensible depression of the water-line. At Woolwich, it is true, the Plumstead Company were obliged to sink, or to bore, to a maximum depth of 525 feet before it could obtain even a small supply; but their works were placed on the lower side, in the direction of the dip of the north and south fault of the Ravensbourne valley, and between the latter and the valley of Cray and Darent; so that the contributing area was forcedly a limited one, especially as the boring was not carried down to the more permeable and more highly-charged strata at the base of the chalk. I have heard of Artesian borings having lately been successfully made in the chalk in Bermondsey; and I have little doubt but that similar results would be obtained by sinking down to the chalk marl near the margins of any of the lines of fault already noticed; the effect of pumping liberally from such wells would, however, only be to exhaust the supply; and, in time, it would be found that the phenomena already observed in the upper chalk would be reproduced in the lower beds. It would be long, no doubt, before this effect would really take place; and in the meantime we may dwell with satisfaction on the discovery of the new sources of supply at Deptford and at Gray's.

The history of the wells in the Deptford valley is the more interesting from the fact of the failure of the attempt to secure a large supply of water from a deep well at Highgate, and it seems to me also to point a moral, which might be very useful to all connected with well-sinking. The Highgate well was commenced with the belief that by passing through the London clay and its subordinate beds, the chalk, the upper green sand, and the gault, a supply would be obtained from the lower green sand, in the same manner as at the Artesian well of Grenelle. It was known that the lower green sand outcropped on the margin of the gault all round the northern, western, and southern sides of the London basin; and certainly there was no *à priori* reason for doubting the continuity of the stratum beneath London. But after passing the various strata, including the gault, in the precise order anticipated, and of a total thickness of 1,113 feet 6 inches, the boring tools, instead of entering upon the lower green sand, as was then anticipated, passed into a series of beds of sands, sandstones, red clays, &c., which have been considered by geologists to belong to the new red sandstone series. From the results of some other borings recently made near London, I am disposed to believe that these beds are members of the Wealden series rather than of the new red sandstone, notwithstanding the apparent confirmation of the latter theory by the results of the borings at Calais, Ostend, and Harwich, to which I hope to be able to call your attention on a future occasion; but to whatever portion of the geological series they belong, the effect of their intrusion has been entirely to intercept the flow of the water of the lower green sand under London. Under such circumstances it was manifestly impossible that water

should be obtained at the Highgate well from that formation; and as the chalk, the chalk marl, and the upper green sand yielded comparatively no water, the prosecution of the works was abandoned. It may be added that the Hampstead Company, at whose expense they had been carried on, was shortly afterwards compelled to part with its district to the New River Company.

Now the lesson which may be learnt from this story seems to me to be, that there is little chance of finding water in any deep well, in formations like the chalk, if that well should be sunk in the intermediate zone between two great lines of fissures, such as have given rise to the outbursts of the springs in the vallies of the Colne and of the Lea; and it is to be observed that the indications of these lines of disturbance are to be traced on the south side of the Thames respectively in the vallies of the Wey and of the Ravensbourne. It would seem as though the subterranean waters accumulated near the edge of the fault, and were there forced to the surface, and it is worthy of notice that the springs which supply the four rivers above mentioned almost all rise on their western banks; that is to say, on the bank corresponding with the upper edge of the dip of the strata. In such cases the water might even be forced up a free open passage between the disrupted faces more easily than it would rise in a well sunk through the superincumbent strata; and a current once established in such a direction, a well sunk near the apex of the intermediate district, would not receive a larger supply than would arise from the precise area itself had laid bare. The water flowing in the intercepted stratum for a width equal to the dimensions of the well would flow into the latter, but no more; and the only way of increasing the yield of such a well would be by driving a heading across the line of dip, at the level of the water-bearing zone. This at least is certain, viz., that at Highgate and at Woolwich, the wells were sunk below the natural water line of the vallies of the Lea, or of the Ravensbourne, and no considerable volume of water was obtained in either of them.

Now to revert to the condition of the actual water supply of London, you must be aware that subsequently to the passing of the Metropolis Water Act of 1852, all the companies have been obliged to remove their sources of supply from positions where the waters were likely to be affected by the tidal action, or by the emanations of large manufacturing districts. The West Middlesex, Grand Junction, and Southwark Companies take their water from the same spot on the banks of the Thames, above the village of Hampton, and above the second lock on the navigation; the Lambeth and Chelsea Companies take their water from Kingston, above the Teddington lock; the East London and the New River Companies take their water from the Lea, the first from a lateral branch from the main stream given off above Clapton, and the latter from the river above Ware; whilst the North Kent Company takes its waters principally from its wells, and partially from the Ravensbourne. In all cases, the companies are bound to filter their waters, and the arrangements for that purpose are of the most elaborate description, and are, moreover, very conscientiously carried into effect. All the storeage reservoirs are covered, and in fact every precaution has been taken to ensure the purity and the good quality of the waters supplied to the inhabitants of London. Whatever can be effected by skill and science for those purposes has been done, and yet month after month the Registrar-General has thought it to be his duty to make comparisons between the water supplies of London and some other towns, which appear to lead to the conclusion that the London water companies supply a fluid of a very objectionable quality, even if they do not point to the necessity of a radical change of the whole system here adopted.

Without carrying you back into the Registrar-General's weekly returns of the public health, I would refer to those published at the beginning of October, November, and December last, in which the following tables appear:—

1860.	October.		November.		December.	
SUPPLY.	Total impurity per gallon.	Organic impurity per gallon.	Total.	Organic.	Total.	Organic.
Distilled Water	0·00	0·00	0·00	0·00	0·00	0·00
Loch Katrine, Glasgow ...	3·16	0·96	3·16	0·96	3.16	0·96
Manchester	4·32	0·64	4.32	0·64	4·32	0·64
Great Yarmouth...	20·96	3·04	...	...	...	...
Well, Great Titchfield-st....	...	...	140·68	16·68	...	...
" Bexley-st., Camberwell	...	...	...	...	214·00	12·80
THAMES COMPANIES.						
Chelsea	21·40	1·88	21·12	1·12	20·84	2·08
Lambeth	21·20	2·68	21·88	1·68	20·28	1·24
Southwark	20·40	1·12	19·64	1·08	21·60	1·80
West Middlesex	20·16	1·24	20·68	1·68	20.04	1·84
Grand Junction	20·28	0·84	20·96	1·36	21·88	1·60
OTHER COMPANIES.						
East London...	23·40	2·04	22·44	1·48	21 48	1·40
New River	20·08	1·12	20·32	1·12	22·30	0·84
Kent	24·64	1·60	23·78	2 68	22·40	0·56

Now, the value of official analyses of this description depends on the extreme care taken with them, and the precautions observed to secure correct results; yet we have this singular fact upon the face of the above table, viz., that the analyses of the supply from the Glasgow and from the Manchester Water Works for the three last winter months—during which heavy rains and snow fell, and the trees and shrubs upon the respective gathering grounds must have furnished a number of dead leaves able to affect the quantity of organic matter in the waters flowing from those grounds—the analyses have been identical. The comparison between the fixed quantity of organic matter assigned to the Glasgow and the Manchester water supplies on the one side, and the variable quantities asserted to be found in the London water supplies, goes for nothing under these circumstances. Again, in none of these cases has any public statement been made of the nature of the organic matter said to be contained in the waters, although it is universally admitted that the injurious effects of the organic matters in question depend upon the quantities of the nitrogenous elements they may contain in a state able to undergo decomposition. The nitrogen of the organic elements which have undergone decomposition is stated by Hofmann and Blyth to be innocuous, but in the tables above given it is included with the other "organic matters;" and it is by no means impossible that the actively dangerous elements may exist in the greatest proportions precisely in those waters which contain the smallest numerical quantities of the class here grouped under the same name. But be this as it may, it is worthy of especial remark that on several occasions the London waters have presented quantities of organic matters which are actually less than those permanently assigned to the waters considered to be "the types of wholesome town supplies."

As to the inorganic impurities in a town supply, there is still so great a variety of opinion as to their influence that it would be presumption in any one man, or even in any one body of professors, to pass a decided opinion on the subject. From the earliest periods to the present day it has been held by the most competent inquirers into this branch of pathology, such as Hippocrates, Chossat, Dupasquier, Levy, Dumas, &c., that waters containing a small quantity of the bi-carbonate of lime in solution are those which are the most advantageous for human consumption. It is precisely the bi-carbonate of lime which constitutes the bulk of the inorganic impurity of the waters flowing from the various formations of the valley of the Thames; and it appears, from the results of experiments on waters obtained directly from the chalk, that there is a larger proportion of that ingredient present in them than there is in the waters

originally derived from chalk springs, but which have flowed for some time in the open air. The wholesomeness of chalk water, when clear and free from mechanical impurities, is too well known to require more than a partial allusion; and it must, therefore, be a matter of surprise, to those who reason upon these matters, to find that the confidential advisers of the Central Administration should thus persistently dwell upon the amount of impurity in the waters supplied to London, when it is by no means proved that the so-called impurities are not positively advantageous under many conditions of a town supply. No details of the nature of the officially branded impurities of the London waters are given; but, from analogy, and from isolated experiments, it is fair to suppose that out of the 21.38 grains of impurity per gallon, there are, in addition to the average quantity of organic impurity, or 1.395 per gallon, about 16 grains of the carbonate of lime with variable proportions of the salts of potash, sodium, magnesia, and calcium. These inorganic substances may even be supposed to play some useful part in the strange chemistry of life; and it is notorious that the waters which do not contain them are often exposed to chemical reactions of a dangerous nature. Thus, for instance; in the case of the Woolwich and Plumstead Water Works Company, the very beautiful system invented by Dr. Clark for softening the chalk well water, was applied under the very able management of Mr. Homersham, and the impurity was reduced from 23 grains to seven grains per gallon. But, at the same time, it is to be observed, that the water so softened acted very rapidly indeed upon the lead cisterns, and services exposed to it; so much so I have been informed, as to entail a very heavy loss on the Water Works Company. Again, the waters of that "type of a town supply," Manchester, are now stated to be able—nay more, to be exposed—to take up lead in sufficient quantities to be deleterious to health; and the story of the lead poisoning of the family of the late ex-King of the French, through the use of a soft water which had been stored in a lead cistern, must be in the memory of all my hearers. I am myself disposed to suspect that there is some degree of exaggeration in the opinion held by those who have written on the deleterious action of soft waters on lead; but the point to which I am anxious to draw attention is this, that until the absolute importance of the actions of various classes of water are known, it is dangerous to cite any one of them as a type of a town water supply, and thus by implication to create a prejudice against other sources of supply. The fact is, that the human constitution is a far more delicate test of the value of a water for this particular purpose than any chemical analysis can be, and as the health of our London population is by no means inferior to that of the population of Manchester, or even of Glasgow or Aberdeen, whilst its moral habits are no better than those of the towns cited as having a more comparatively pure and soft water supply, it seems to me that there is something at least injudicious in the tone of the monthly criticisms upon the quality of the water distributed by the London Water Works.

There is, moreover, a very serious consideration which, to my mind at least, overrides the whole of this discussion of the quality of the London water supply, viz., that if medical and chemical authorities should agree that the present source of supply ought to be abandoned, there is positively no other source to which we could resort. The notion of forming gathering grounds and catchwater reservoirs, on Bagshot-heath, was too absurd for even the late General Board of Health to support, after it had been exposed to adverse criticisms for a few weeks. The scheme for collecting the waters from the Hind Head district also fell to the ground on examination; and I, myself, from personal inspection of the district, know that not only was the quantity of water said to be obtainable from it seriously exaggerated, but that the estimated expense of the works was as seriously below what it really would have been. Even if both these catchwater schemes for securing a soft water supply were executed at any cost, they could not furnish the quantity required for the enormous population of London. At the rate of the Liverpool and of the Manchester Water Works, where the rain-fall is greatly in excess of that of London, it would require gathering grounds in the proportion of about 25 acres per 100 individuals; or, for the supply of the metropolis, it would require not less than one thousand square miles, or about $\frac{1}{8}$th of the total estimated water shed of the Thames; and it is preposterous to suppose that under any conditions of springs fed from other sources the districts it has been proposed to resort to could yield anything approaching the volume which would be required. As it is, the abstraction of fresh water from the Thames is in dry seasons becoming an evil of serious magnitude to the navigation, even when the New River, the East London, and the Kent Water Works Companies derive their supplies from other sources than the Thames. What would be the case if the whole of the 100,000,000 millions of gallons now supposed to be consumed every day in London were withdrawn from the basin of the Upper Thames? It must, indeed, be observed, that if there be any real value in the opinion as to the hygienic superiority of the pure soft water, the whole of the town supply must be of that description, unless the new source be resorted to simply as the basis of a scheme in opposition to the companies already in possession of the supply. Far be it from me to pre-judge the question as to the necessity of any such opposition. All I seek at present to show is, that so far as regards the quality of the water supplied to London, there is no immediate reason for a change, and that there are as many objections to be raised to the qualities of the model municipal supplies as there are to the unjustly attacked waters distributed by the London water companies.

In the year 1856, a series of articles, under the head of "Visits to the London Water Works," appeared in the *Journal of Gas Lighting and Water Supply;* and in the same year a report to Mr. Cowper, President of the General Board of Health, was published, in both of which an account was given of the works executed by the Metropolitan Water Works, in compliance with the requirements of the Metropolis Water Act, 1852. At the date of the publication of those documents, nearly all that had been contemplated for the alteration and improvement of the existing system of supply had been completed, and since then little else has been done beyond the extension of the distribution into the continually extending suburbs of our marvellous agglomeration of houses, and some trifling modifications of the machinery required to meet the wants of some outlying districts. Perhaps the most remarkable events which have taken place since 1856, in the history of the London water supply, have been the completion of the works on the New River at Hornsey; the sinking of the new wells at the Kent Water Works; and the utter failure of the Woolwich and Plumstead Company, from a combination of circumstances into which it is not my province to enter. The results of the very costly, and very equivocally successful, experiments at Orange-street, and at Duck Island, have in no wise affected the question of the metropolitan water supply, and the schemes for supplying the extreme east of London from Grays, or the extreme south-east from the Cray, or the Darent, remain still in the state of projects; the Hampstead Company, as was before said, has been merged into the New River Company. At the present day, then, the companies which supply the metropolis are, 1. New River; 2. East London; 3. Southwark and Vauxhall; 4. Lambeth; 5. West Middlesex; 6. Chelsea; 7. Grand Junction; and 8. Kent. The capital embarked in these undertakings is enormous. From the returns to the General Board of Health, it seems that the total cost, up to 1856, had been not less than £7,102,823; and at the present day it cannot be much below 7½ millions. In 1856, the aggregate nominal steam power employed was not less than 7,254 horses, and the quantity of water pumped was 81,025,842 gallons per day on the average of the year. Nor would it be unfair to sup-

pose that, in consequence of the increase of population since the date of these returns, that the present rate of supply must be nearly 100,000,000 gallons per day; or at the rate of about 40 gallons per head of the inhabitants. A service of this character cannot be lightly disturbed, and it behoves our rulers to observe especial caution in the manner in which they allow their agents to create feelings of dissatisfaction with a class of public contractors who have risked so much, and have laboured so earnestly, to discharge the duty they have undertaken. Perhaps the best proof of the earnestness with which the London companies have entered upon their task is to be found in the fact that they have spent no less than 2½ millions sterling for the removal of their sources of supply, for the filtration of their waters, and for the improvement of their distribution since the year 1852.

Before closing these remarks I cannot refrain from saying that the inhabitants of London have been very far from seconding either the intentions of the Legislature in passing the Act of 1852, or the Water Companies in their attempts to improve the quality of the supply. The legislature, unquestionably, intended (whether rightly or wrongly) to facilitate the introduction of the constant service, as it is called, into London; and the Companies have executed all the works incumbent upon them for that purpose. For my own part, I believe that the provisions in the Act of 1852 on this subject must always remain a dead letter; because the substitution of the machinery required for a distribution on the constant supply, for one upon the present intermittent supply, would involve an outlay on the part of the public equivalent to between £5 and £10 per house. Moreover, the waste of water upon the constant supply in a town like London—if it attained anything like the proportions it has done at New York and Boston—would instantly compel the adoption of measures to limit the rate of supply. Practically I believe that the distribution of water in London must continue to take place as it does at the present day; but so long as this is the case, so long does it behove the London public to exercise a rigid superintendence over the machinery of distribution which is under their own control. It is in vain to change the sources of supply for the purpose of avoiding organic impurity; it is useless to filter the water and store it in covered reservoirs, if, directly that water enters the houses it is intended to serve, it is poured into cisterns which are not cleaned out from year's end to year's end, or into butts teeming with every description of organic and inorganic impurities. In this matter, as in many others connected with social and hygienic science, the public requires to be taught that the remedy for the most pressing of their evils lies in their own hands, and if the householders of London would only clean out their cisterns once a month—at least once every three months—we should hear very little of the "total impurity per gallon" of the London waters. As it is, people who are not accustomed to think on these matters are apt to forget the real proportions of the impurity said to be present in those waters, and the public requires to be reminded that twenty-two grains per gallon only mean one grain in about 3,182 grains; and that 1·4 grains of organic impurity of all kinds only mean one grain in 50,000. If these impurities be poisons, they may be suspected to be slow poisons of the kind Fontenelle could, at the age of 80, afford to jest about, as he had taken them every day of his life, and we Londoners have an unfortunate habit "of persevering in living" under their effects.

It may be worth while to add that the average cost of the London water supply does not exceed five per cent. on the rental, for a distribution so copious as to attain the rate of 40 gallons per head per day, or nearly seven times as much as it ought to be, for, in fact, no one really uses much more than six gallons per day. They only who take the water pay for it, and the trading companies who supply the public are obliged to suffer all risks, and to contribute very largely to all public burthens in the shape of rates and taxes; for instance, the assessments of the water companies to the poor rates vary between 9 and 32½ per cent. of their total rentals; and, moreover, they are by the very necessities of their position, compelled to adopt every improvement in mechanical or chemical science as it arises. A very long discussion might be raised upon this part of the political economy of the discharge of municipal services, but it may suffice here to say that the experience furnished by the management of the Manchester Gas Works, and of the Southampton Water Works, shows that wherever municipal bodies take upon themselves the discharge of functions which must be paid for in some way or other, there is a great danger; firstly, that there will be injustice in the assessment of the payment; and, secondly, that in the mode of working there may be extravagance, even if not abuse. The modern system of paying for the deficiencies in municipal budgets, occasioned by the inadequate charges for gas and water rents, by means of general and district rates, is, after all, only a disguised method of making the community at large pay a portion of the burthen the consumers alone should bear. The system adopted in London, where they only who receive a benefit pay for it, is certainly the fairest one, and, in the end, past experience has proved that is the cheapest.

The conclusions I am induced to draw from a careful study of the question of the present condition of the London water supply are as follows:—

1st. I think that the quality of the water is on the whole extremely good, and that the Companies take every precaution in their power to maintain its character.

2nd. I am convinced that it is utterly impossible to secure a supply which should attain the supposed ideal type, even if that were desirable, which I do not believe.

3rd. I think that the greatest present improvement in the quality of the London waters would be effected by rendering it impossible for the population on the banks of the Upper Thames and its affluents to use the river as their outfall sewers. With all the local impurities thus cast into the Thames, the quantity of organic matters its waters contain do not, however, exceed in any notable quantity those contained in deep-seated chalk springs which cannot possibly receive sewage.

4th. It seems to me that any extension of our present supplies should be sought for rather on the east than on the west of London, and on the edges of some of the great lines of disturbance there existing.

5th. It seems also to me that it would be a mere waste of money to attempt to execute any system of catchwater supply.

6th and lastly. I think that there is both great injustice and great want of a true spirit of philosophy, in the insinuations which are now constantly urged by the Registrar-General on the subject of the impurity of the London waters. Pure water does not exist in nature, for even rain water contains appreciable quantities of ammonia; thus, Barral states shat the rain water of Paris contains about three in 100,000 of organic impurity; and the well of Grenelle yields a water containing about 15 in 100,000 of impurity of every kind; but even if pure water could be obtained, it would be necessary to ascertain the precise nature and effects of the extraneous matters, in any other definite water supply, before applying to those matters the term *impurities*. The Registrar-General's monthly reports, moreover, not being drawn up with the assistance of the officers of the Companies, can only be regarded as *ex-parte* statements, by one who evidently has a strong bias against the Companies or their sources of supply.

DISCUSSION.

Mr. S. C. HOMERSHAM said he felt called upon to dispute some of the statements put forward in the paper as facts. To his great surprise, Mr. Burnell had stated that the Plumstead Waterworks Company was defunct. The Plumstead Waterworks Company was established in 1852, was opened in 1854, and had remained so till the

present day. They had never for an hour ceased to supply their customers, and they had an increasing number of customers every year since the works were opened. That was a fact which might easily have been ascertained by Mr. Burnell, and he would have found upon inquiry that the water of the company was now supplied to 3,400 houses. It was true that at one time there were disputes between the directors on the question of building the works upon leasehold ground, &c., and a Chancery suit and other legal proceedings had ensued in consequence; but that had never affected the water supply to the public. The well had been sunk in the first instance to yield 600,000 gallons per day, and as the tenants of the Company increased, in order to increase the supply, a bore-hole, 18 inches diameter, was put down, from which a further yield to the same extent, making 1,200,000 gallons per day, had been obtained. He was therefore much surprised at the statement in the paper that would lead them to believe the Plumstead Water Company had ceased to exist. Mr. Burnell had alluded to the softening process adopted by Dr. Clark, and stated that the water injuriously affected the lead service pipes. Now he (Mr. Homersham), as engineer of the Company, was enabled to state that the water did not act upon the lead in the least degree; that it was supplied to 3,400 houses, in almost every case through leaden pipes, and that he had never heard of any complaint, except in one case, in which the lead used for a cistern was of such bad quality, that the contractor, to save his own credit, had put up another tank at his own expense. He could therefore confidently state that in the case of the Plumstead water, there was no foundation for the statement that the water acted perniciously upon the leaden pipes and cisterns through which it was conducted and stored in the houses of the consumers. Pure, soft, spring water, free from organic matter, or free from carbonic acid, had no action upon lead; and such was the spring water supplied by the Plumstead Company. Dr. Clark, in his paper read before this Society in 1856, expressly stated that softened chalk spring water had no action upon lead. A series of tests upon such water had been made, which proved that the softened spring water had no action upon lead. With regard to the general water supply to London, Mr. Burnell had characterised it as very good; that chemists could only detect so small an amount of organic matter in the water that it was immaterial whether it existed or not. That statement accorded with the opinion given in 1849 by Sir William Clay, chairman of the Grand Junction Waterworks; but Mr. J. Simon, who presided over the meeting of this Society when Dr. Clark read his paper, showed the deleterious action which water containing organic impurities had upon the inhabitants of a large district of the metropolis, giving the facts taken from an authorised investigation into the subject after the last visit of the cholera.* That was a comparison, not between pure water and contaminated water of a district, but between waters more or less contaminated by town drainage; and yet chemists told them that such water contained next to nothing of organic matter. Therefore he considered these chemical tests as to organic matter in water went for very little. Microscopic examination showed that there were all sorts of animalculæ, and all sorts of impurity in the river water, whilst none at all existed in the spring water. One great objection to the water supply of the present companies was that the drainage of a large urban population was carried into the Thames, from whence the supply was taken. He believed there was a population of 700,000 upon that drainage ground. The water was also polluted by the manure put upon the land, and also by the barges going up and down the river, and various other influences. In addition to this, it was to be remarked, that river water in summer time was heated, whilst in winter it was excessively cold. The temperature of the rain-water in summer was sometimes as high or higher than 72 deg., and in the winter it was as low as 33 or 34 deg. Fahr. That was not desirable in a town supply of water, because the mere raising of the temperature of the water deprived it of a large portion of oxygen gas, and caused the fermentation of any fetid matter it might contain. On the other hand, the water froze very easily in the pipes in the winter. Now with regard to spring water it was taken from the well at 49 or 50 deg. of temperature in summer, and supplied at only 2 or 3 deg. higher temperature, whilst in winter it was only 2 or 3 deg. colder than when taken from the well. That, he considered, was an important circumstance, and especially in the matter of drainage. If they put water through the drains of houses at 51 or 52 deg. of temperature instead of at 72 deg., it was better for the sewage and for the health of the inhabitants. It had been stated in the paper that certain impurities in the water supply of London were pointed to in the registrar-general's returns, but that no analysis was given as to the quality of the water. Upon that point, however, they had the able analyses of Dr. Hassall. Mr. Burnell had advanced an opinion before this meeting that it was questionable whether they would get a better supply of water than they had at present. Now, he (Mr. Homersham) ventured to say that at a comparatively small expense, London might be supplied with 100 million gallons of spring water per day, containing only two or three degrees of hardness, and free from all unwholesome matter, and why had not this been done before? Simply because the government interfered between the consumers of water and the companies, and prevented a supply being brought into London from the chalk springs. The idea of a supply of water from the chalk was at one time ridiculed, but he might state that the Kent Water Company, seeing the success of the Plumstead works in 1854, with which Company they were in competition, had since sunk a well in the chalk, from which they obtained one a half million gallons per day, and had subsequently sunk two other wells, the three yielding three and a half million gallons per day, so that at the present time they derived all their supply from chalk wells, whereas a few years ago they had ridiculed the idea of getting a supply from the chalk springs. That was the effect of free competition. Mr. Burnell had alluded to the Trafalgar-square wells, as an instance in support of his assertion that the level of the water under London had gradually been lowered; but he (Mr. Homersham) would say that whilst it was true that the water in some of the large wells of London had been lowered, the Trafalgar-square well, which had been pumped from the last 18 or 19 years, stood just as it did formerly; and the same remark might be made as to the wells of the Kent Water Company and the Plumpstead Company, to which he had alluded, as well as very many others. He thought such statements were calculated to mislead the public as to the possibility of obtaining a supply of water for London from the chalk. He would undertake to find a contractor who, at a reasonable price, should furnish a practically unlimited supply of water from the chalk, free from impure organic matter, at a temperature of about 50 degrees, and soften this water to only two or three degrees of hardness. He (Mr. Homersham) had gone fully into the question of the quantity of water to be obtained from the chalk in his paper read before the Society on Feb. 2, 1852.*

Mr. J. T. BATEMAN, F.R.S., as the engineer of the Loch Katrine or Glasgow water works, and also of the Manchester water works, felt considerable interest in this subject. He was a great advocate for pure soft water. Mr. Burnell had alluded to the reports of the Registrar-General, and had remarked upon the uniformity of the analyses, during the months of October, November, and December, of the waters of Loch Katrine and the Manchester water works. He believed he could satisfactorily

* Vide Dr. Clark's Paper and Discussion thereon. *Society of Arts Journal*, vol. iv., p. 439.

* See *Society of Arts Journal*, Vol. 3, p. 168.

explain that circumstance. The analysis of the water of Loch Katrine was first made in 1854, at the time when a great outcry was made upon the subject of soft water supply, in consequence of the alleged action of such waters upon lead pipes. The water of Loch Katrine varied very little in quality in summer and winter, and it was generally regarded as the type of a good water supply. We was, therefore, anxious that old analyses of that water should not be relied upon, but that the test should be applied to the water as delivered in Glasgow after the works were completed. He therefore sent up a supply of the water from Glasgow from time to time, in order that analyses might be taken of the water as delivered for the use of the inhabitants of that city, and not of the water as taken directly from Loch Katrine. Samples of the water of Manchester were sent in a similar way at various times, at intervals of two or three months, and of that water analyses had also appeared. It made very little difference whether these analyses were repeated once a month or once in a year, for there was in point of fact very little variation indeed. He had the results of the analysis of the Manchester water, made in 1844, by Professors Miller, Penny, and Redwood, from which it was shown that there were 3·6 grains of total impurity per gallon, 1 grain of organic impurity, and 1½ degree of hardness in the water supplied to Manchester, and the analyses since that time varied very little, as would be seen by those referred to by Mr. Burnell. The water of Loch Katrine was received into immense basins, 700 or 800 feet in depth, and the vast body of water thus collected might be conceived from the fact that during the late most severe weather, when Loch Vennachar was completely frozen over, as well as the lower part of Loch Lomond, the temperature of the air being 12 or 14 deg. below zero, there was not an atom of ice on Loch Katrine, and the water, after travelling through the bowels of the earth for a distance of 27 miles to the service reservoir near Glasgow, gained 2 deg. of temperature, and was delivered at the end of the tunnel at 41 deg. of temperature in the coldest weather; in fact, all along the line of aqueduct, warm air was emitted from the shafts of the tunnels, and the vapour there condensed like steam from a locomotive engine all along the hills under which the water travelled. In the case of Manchester, the water was, for the most part, taken direct from the springs, without being stored in reservoirs, which were only resorted to in the event of a short supply. The daily supply of pure spring water at the Manchester Waterworks varied from six or seven million gallons to thirty millions. The supply to the city might be taken at eleven million gallons per day, ten-elevenths of which were spring water. That accounted for the uniformity in the quality of the water there. Mr. Burnell had made some remarks upon the desirability of the presence of bi-carbonate of lime in the water; that was supporting the old theory, that it was necessary to drink hard water for the production of bone in the human frame. Now, he would remark, as the result of his personal observation, that the finest men in Great Britain were those who lived in districts where no hard water could be obtained; there they had the largest-boned specimens of human beings. In Aberdeen and the east coast of Scotland, and in the granite districts generally, they had no bi-carbonate of lime in their water, and finer men he had never seen, and the same remark equally applied to the lowlands of Scotland, about Melrose, and to the Cumberland and Westmoreland Lake districts. There they had no hard water at all. In Wiltshire and Dorsetshire, which were chalk or lime districts, they found perhaps the smallest-boned specimens of humanity that were to be met with all over the country. He believed it was better, on all accounts, to have soft water without any lime. Another consideration with regard to hard water was its cost. He had on a recent occasion gone into a calculation of the saving which was effected to Glasgow from being supplied with soft water. The water of the Clyde, from which the supply was previously taken, contained from seven to nine degrees of hardness, and since the supply of soft water had been furnished there was a saving in large printing and bleaching establishments of fully one-half in the article of soap alone. In fact, in some cases the saving had been equal to five-eighths, for since the water of Loch Katrine had been supplied, it had been found that three boxes of soap were equal to eight boxes formerly, and the work was done better with the diminished quantity. In fact, the saving from all causes from the use of soft water, was £40,000 a year, and paid the water-rates of that portion of the city in which the change had taken place. It was equal to a free gift to the city of £1,000,000. In the case of London, a supply of similarly soft water, taking into account the greater hardness of the present supply, would be equal to a free gift to the City of £10,000,000 sterling. With regard to the action of soft water upon lead, an investigation, of a very complete and expensive character, into that matter had been made at Glasgow. When the main difficulties in the supply of water from the loch were got over, they were astonished to find that some samples of water were produced before the parliamentary committee, as showing the effects of the action of soft water upon leaden pipes. The town of Inverness had been for 27 years, at that time, supplied with water from Loch Ness through services of lead and wood cisterns with an intermittent supply, and yet no case of lead disease had ever been heard of; and he had had in his possession, for the last seven years, portions of pipes which were beautifully coated with bicarbonate of lime, carbonate of lead, or some other substance of that kind, which perfectly protected the water from any injurious effects of the lead. To take another case, Whitehaven was formerly supplied with hard water, which was changed for a soft water supply from Ennerdale Lake. The mortality returns for four years previous to the introduction of soft water showed an average of 35 deaths per thousand, whilst upon a supply of soft water being furnished to that town, the average of the following four years showed that the mortality was reduced to 23 in the thousand. Amongst other subjects alluded to in the paper was that of the management of those matters by corporations, and Mr. Burnell had referred to two cases especially, viz.:—the Manchester Gas Works, and the Southampton Water Works. Now the former, so far from being an example of bad management, was one of the most lucrative concerns ever adopted by a public body. It was an arrangement by which the township of Manchester had established its own gas works, and, while supplying excellent gas, had gained a sufficient amount of profit to be enabled to expend more than half a million of money in the public improvements of the town; and in the case of Glasgow he might add that the results of carrying out the same system of management by a corporation, had been the improvement of the navigation of the Clyde from a depth of water of 3 feet and annual dues amounting to £300, to 22 feet depth and a revenue of upwards of £90,000 per annum.

Mr. LOTT said that Mr. Burnell had reproached the public of London with apathy upon the matter of the water supply. There was something more than apathy—there was disgust felt at that legislation which had given rise to the present monopoly of the water supply, and which enabled the existing water companies to increase their charges fifteen per cent., a power they were not slow to avail themselves of. It was a public misfortune that the splendid legacy bequeathed by Sir Hugh Myddelton to his fellow-citizens had led to the formation of a private company, whose profits were almost fabulous, whilst it held despotic sway over the water supply in the district. The remark had been made that the Camden-town Water-works Company had been compelled to merge their concern into that of the New River Company. The plain history of that matter was, that when the Camden Town Company had a short supply of water, they applied to the New River Company for assistance

and the latter made it a condition of their assistance that the former should give up some of their districts, until gradually the Camden Town were compelled to give up district after district, until the New River Company got all the streets into their own hands. He was, however, happy to say that in his place in the Corporation he was the means of arresting for a time the death-struggles of the Hampstead Water Company, inasmuch as upon their applying to the Corporation for a renewal of their lease of some lands at Highgate, which were the property of the Corporation, from which they obtained their supply, the payment of a very large sum was fixed by the surveyor as the condition of the renewal; but feeling sympathy for the Company in its misfortunes, and being a decided opponent to monopoly, he succeeded in inducing the Corporation to grant a renewal of the lease upon terms that were almost nominal. In 1835 a great question was raised with regard both to the quantity and quality of the supply of the New River Company, and having employed a chemist to make an analysis of the water, he brought the matter before the attention of the Corporation. Some of the governors of the company attended before the Corporation on that occasion, and the result was a considerable improvement both in the quantity and quality of the water. That was the way they were obliged to watch these companies. He would say one word with regard to municipal bodies failing in the management of these matters. It was too much the fashion in the present day to abuse these corporations. For his own part he would say he very much regretted that the Corporation of London had not taken the matter of water supply into their own hands. If there was a profit to be made out of it he believed they would have been as successful in that respect as the Corporation of Manchester had been in the case of gas, and the profits so made would have gone in aid of the public rates.

Professor TENNANT inquired of Mr. Bateman from what formation the water of Manchester was principally obtained.

Mr. BATEMAN replied from the millstone grit.

Mr. SPENCER understood Mr. Bateman to state that the profits from the Manchester water supply went in aid of the gas supply of the same town.

Mr. BATEMAN replied that the case was just the reverse. Half the profits of the gas went in reduction of the water rates. The present water rate was sixpence in the pound, supplemented by half the profits from the gas.

Mr. SPENCER would add, with regard to the action of soft water upon lead, that during the time he was engaged at Glasgow in the investigation of that question, he visited Whitehaven, which was distinguished by having softer water than almost any other town in the kingdom, and he could state, as the result of the investigation by some of the most eminent chemists of the day, that no perceptible action had taken place upon the lead pipes there. In that case, the water was below one degree of hardness. Some time subsequent to that, he was called upon to make an examination as to the corrosion of water pipes, and supposing it to be a case analogous to that of Whitehaven, he procured some pieces of the lead pipes. He would, in the first instance, state that the water was very soft, and corroded the iron main pipes to such an extent that the delivery of six-inch pipes was reduced to the quantity that would be given through three-inch pipes, owing to the extent to which corrosion and deposit had gone on, and in some portions of the town the supply was partially stopped. But on examining the leaden pipes, he found there was a very beautiful coating of carbonate of iron in the interior; hence, if it had not been for the action of the water upon the iron piping, there was no doubt there would have been corrosion of the lead. The report upon the subject was that the health of the inhabitants had been saved at the expense of the iron pipes. He did not say that they ought not to have to gone to Loch Katrine for their water,—he thought it was the best thing they could do; but he said, until the pipes became coated in the way he had described, with some deposit from the water, the water of Loch Katrine was calculated to have an action upon the lead.

Mr. FRED. BRAITHWAITE remarked that the question of water supply to the metropolis was a very serious one, and might with propriety be discussed before this Society; at the same time he thought they ought to be careful how they disturbed the minds of so vast a population as to the quantity and quality of the water with which they were supplied at the present time. It must be admitted that the great source of supply at this moment was from the river Thames. The Government, some years ago, very carefully investigated this question, and insisted upon the various water companies taking their supply from the river beyond Teddington-lock, where it was as free as possible from contamination; and if they looked at the water which was now supplied they would find that they had water quite sufficiently pure. It was stated upon analysis to contain a certain number of grains of impurity per gallon —carbonate of lime being considered an impurity. Hypothetically distilled water only was pure, and one grain of carbonate of lime might thus be called an impurity; but could this be considered really an impurity? A gallon of water contained 70,000 grains, and analysis had shown that one-and-a-half grain, or at most two grains of organic impurity existed in that number of grains. He was, therefore, anxious that they should not create in the public mind an alarm that at the present time the supply of water to London was of a nature injurious to health. It was true that the water alluded to by Mr. Homersham, derived from chalk-springs, was of a very soft character, with an absence of organic matter which was found in other water, but in that case Dr. Clark's system was employed to precipitate the carbonate of lime; such a plan, however, he thought was impracticable in a commercial sense, and he would ask Mr. Homersham whether the result was commercially profitable in the case of the Plumstead Waterworks?

Mr. HOMERSHAM replied, that the net profits of the company amounted to £3,700 last year.

Mr. BRAITHWAITE was, nevertheless, inclined to doubt the commercial success of the undertaking. The great question was, was there any town in the kingdom supplied with so large a quantity of water, of such purity, and at such a price, as London? The supply was estimated at 40 gallons per head daily, a far greater quantity than was fairly required. He had no hesitation in saying that if last summer they had had a season of dry weather, like that of the previous year, London would not have had the supply of water it required, for they had scarcely a gallon of water flowing over Teddington Lock during the summer of 1859. During the last year they had a more abundant supply, the rainfall having been about 12 inches beyond the average. They had now abundance of water in the Thames above the lock, and the river had not been in a better condition for the last thirty years than it was at the present time.

Mr. WM. HAWES said that, judging from the papers which had lately been read before the Society, he had expected to see the walls of the room covered with diagrams representing the fearful amount of pollution infecting the water supply of London, with microscopic illustrations of that pollution, tending to show that the inhabitants of London, in addition to injury from adulterated food, were liable to be poisoned with the polluted water which they were obliged to drink. This discussion had shown that, notwithstanding all the alleged impurity of the water of London, the amount of the impurity was so infinitesimally small that they might go on drinking it without undue alarm as to any injurious effects upon their health. It was important that exaggerated statements should not be put forward. They had been told that in districts where this fine soft water was alone drank the finest specimens of humanity were to be met with. That might be quite true in the abstract; but on the other hand if they went to those countries where only the purest (so called)

water, the snow water, was drunk, as in Switzerland, they found the most diseased population perhaps in all Europe, who were characterised by the great prevalence of goître amongst them. Isolated cases were not to be relied upon. He thought they might undoubtedly appeal to the general health of the city of London as the best proof that they were on the whole well-supplied with what they ate and drank. They were told that the charges for water supply in London were exorbitant—those of the New River Company in particular. If they took the West End of London, for example, he believed the average rate of charge was from four to five guineas per annum for such houses as were found in the squares north of Oxford-street. He thought that could not be called an enormous charge for water. The New River Company was commenced very many years ago, when London was comparatively small in extent, and the demand for water had gone on rapidly increasing. The supply, as far as the New River Company was concerned, was at one time limited, but now the case was different, and the accumulated profits of the undertaking had put the original shareholders into a position to make very large profits upon the early nominal capital. They were told that the corporations of Glasgow and Manchester were types of perfection in these matters of supply of gas and water, but did they wish to have the supply of the necessaries of life placed in the hands of corporations? Was the corporation the power to which they would wish to entrust the supply of this great city with those necessary commodities? He contended that the best means of supplying a great city like London was through the agency of great public companies and commercial firms, under the vigilant eye of the public. That was, in his opinion, the best as well as the cheapest way of getting a supply of those articles which every large city required.

Dr. WYLD remarked that it had been advanced by some speakers that evening that they could not have a better supply of water for London than that which was derived from the Thames. He could only state that during a residence last summer at Kingston, he found the water of the Thames opposite that town in a most offensive state. He quite agreed with the recommendation given by Mr. Burnell, to look to the state of their cisterns. As a matter of personal experience he could state that, having been without water at his residence for some time during the late frost, the opportunity was taken to inspect the state of the cistern in his kitchen, when there was found to be at the bottom an inch in thickness of foul slimy matter. This showed the importance of having the cistern periodically cleaned.

Mr. A. S. HARRISON was able to state, from his personal experience as a practical plumber in the City of London, that very great negligence prevailed with regard to the cleansing of the cisterns; and instances were of very frequent occurrence in which large quantities of filthy matter had been suffered to accumulate at the bottoms of tanks. The deposit itself resembled lime mixed with a yellow-coloured matter, and he concluded that it consisted principally of the lime deposited from the water, coloured by the rust of the iron pipes through which it passed. He had taken up some miles of pipes in the City, and he invariably found that they were covered with a thin coating, which he presumed was lime, which was easily removable with the finger, but which the passage of the water itself was not able to remove. With regard to leaden cisterns he believed that injury frequently arose from a galvanic action taking place between the lead and the solder connecting the bottom and sides of the cistern, as it was at those parts that any failure usually took place. With regard to the supply of water to London, he was in favour of constant service and supply through meter. In Billingsgate Market and other places where very large quantities of water were used, that system had been adopted with satisfactory results both to the consumers and to the companies supplying the water.

The CHAIRMAN, in asking the permission of the meeting to present to Mr. Burnell their thanks for his paper, would offer only one or two remarks. The discussions of this Society, useful as they were, were sometimes of a somewhat discursive character, and certainly they had had that evening topics which were not quite pertinent to the subject before them. Mr. Bateman, in a very interesting description of the water supply of Glasgow and Manchester, had sought to claim the large and sinewy frames of some of his Scotch friends as the products of soft water, whilst he had pointed to the feeble and degenerate growth of some of our Southern people as the unfortunate results of hard water. If the paper which had been read that evening painted in too favourable colours the water supply of the metropolis, the reverse of the picture had been offered to them by Mr. Homersham and other speakers, in terms not over flattering to the Water Companies. Much of the value of these meetings of the Society arose from the freedom of discussion which prevailed in this room, and that corrections which exaggerated statements were thus sure to receive. Notwithstanding all they had heard, he hoped the audience would go away with no great amount of discomfort from the fear that they would not have a sufficient supply of good water for their use during the year 1861. He must confess he went very far with Mr. Hawes in the distaste that gentleman had expressed against too much interference in these matters on the part of municipal bodies. The great characteristic of the English people was, that they relied upon themselves, and if they did not get everything absolutely perfect, they had the satisfaction of knowing that in providing for their wants by their own independent agency, those habits of self-reliance were formed by which as a nation we were especially characterised. He was therefore sure he should have the unanimous sanction of the meeting to a vote of thanks to Mr. Burnell for his paper.

A vote of thanks to Mr. Burnell was then passed.

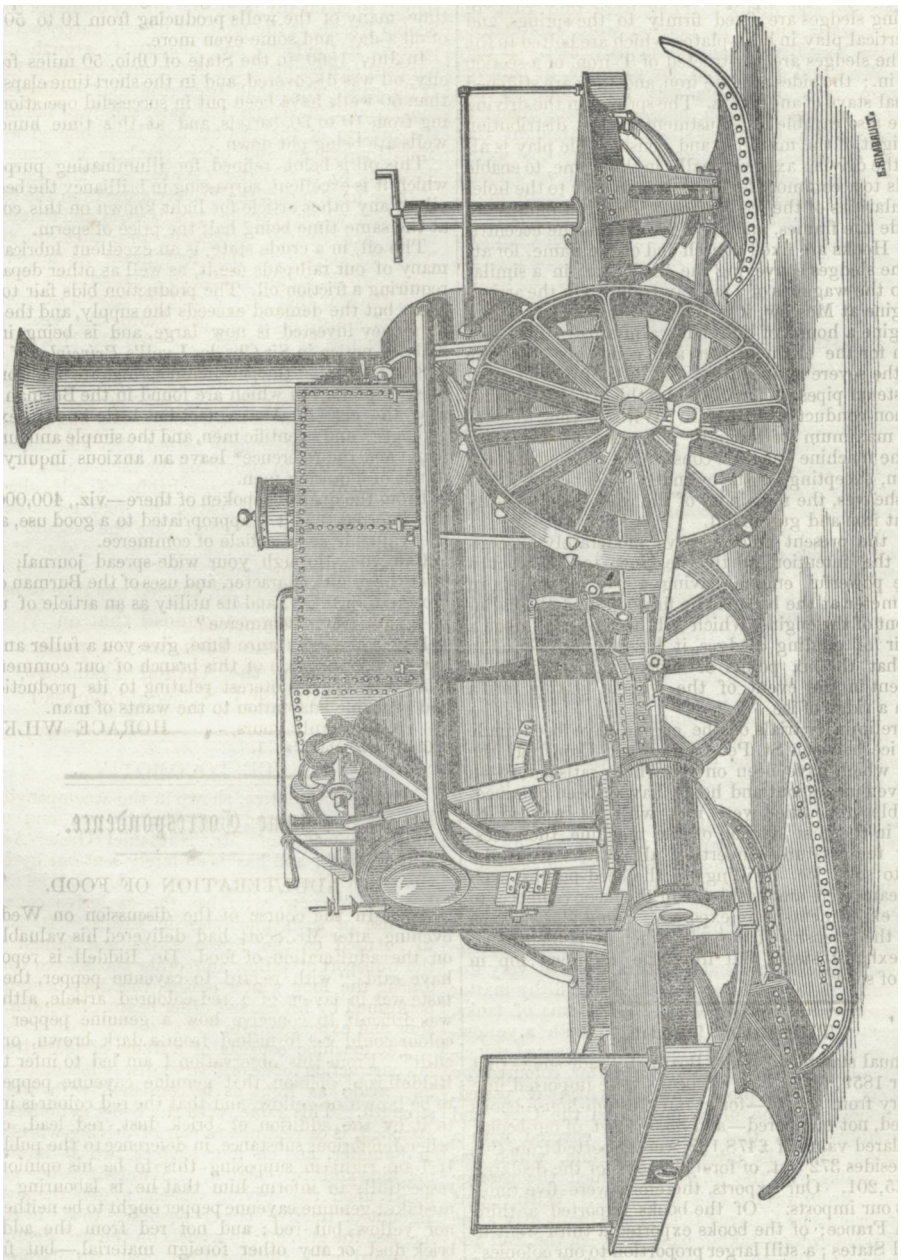
The Secretary announced that on Wednesday evening next, the 13th inst., a paper "On the Uses of Tea in the Animal Economy," by Dr. Edward Smith, F.R.S., would be read.

ICE LOCOMOTIVE.

The ice locomotive, shown in the accompanying sketch has been constructed from the designs, and under the superintendence, of Mr. Nathaniel Grew, Assoc. Inst. C.E., F.R.S., and has been lately sent out by Mr. Edw. Corey, of New Broad-street, to M. Gabriel Solodovnikoff, of Moscow, who has the exclusive concession for the use of such machines in Russia. It is intended to be used on the frozen rivers and inland lakes for the transport of tallow and other goods from the interior, during the long winter season, this duty being at present performed by horses and other beasts of burden, at a very slow and expensive rate.

The machine consists of a frame of plate-iron, similar in construction to the ordinary railway locomotive framing, bu made as light as is consistent with the requisite strength. This frame, with the boiler cylinders and tank attached, is carried upon a pair of driving-wheels, four feet n diameter, and on four sledges, two at the front of the machine and two behind, the weight being mainly disposed upon the driving wheels, to give them the utmost amount of tractive power possible; to aid in this, and to increase the grip of the wheels on the ice, steel spokes are furnished with the machine, and can, if necessary, be screwed into the tyres of the driving-wheels, on the same principle that a horse's shoes are "roughed" on a slippery winter's day. As little as possible of the weight is borne by the leading sledges, to facilitate steering the engine in its passage over rough or uneven parts of the ice; and to effect this, the cylinders are fixed to the frames behind the driving-wheels, or at the fire-box end of the boiler. The cylinders are six in. diameter, with a stroke of piston of

16 inches, and are firmly bolted to the outsides of the frames, and give motion to the wheels through a connecting rod working on a crank pin fixed in the wheel centres. The outside cylinder "system" has been adopted, to enable a straight driving angle to be used, and avoid the expensive and easily broken double crank shaft. The engines are fitted complete, with expansion links, reversing motion, feed pumps, &c., similar in character to locomotive work, the whole being made as strong as possible with a due regard to weight. Steam is supplied to the cylinders from an ordinary tubular boiler with fire-box; the latter is made large in proportion, to enable wood



to be used as fuel; for the same purpose the tubes are fewer in number and larger in diameter than are usually applied where coke or coal can be procured. The working steam pressure is intended to be 100 lbs. on the square inch. The feed water supply is maintained from a tank saddled on the barrel of the boiler, this tank being intended to be filled with snow and ice when travelling in a region where water is a solid. To convert the ice into water, a steam jet is applied from the boiler. The capacity of the tank is about 100 gallons.

To enable the machine to be guided whilst moving, an apparatus for the purpose is fixed to the leading sledges. On the foot-plate in front of the engine, an upright tube or column is fixed, carrying with it a spindle capable of being

moved from above by means of a cross handle; to the lower end of this handle is fixed a pinion, gearing into a segment of a wrought-iron wheel, fixed to the sledges, but so arranged as to leave the carrying springs independent; thus, on the handle above being turned, motion within certain limits is given to the leading sledges, and the machine receives its proper direction when travelling. The trailing sledges are fixed firmly to the springs, and have a vertical play in horn-plates, which are bolted to the frame. The sledges are constructed of T-iron, of a section of $2\frac{1}{2} \times 3$ in.; the sides of plate iron, and they are stiffened by diagonal stays of angle iron. The springs on the driving wheels are also capable of adjustment for the distribution of the weight of the machine, and considerable play is allowed to the driving axle vertically in the frame, to enable the wheels to accommodate themselves readily to the holes and irregularities of the ice surface. The feed pumps are fixed inside the frames, and are worked from the eccentric sheaves. Hooks are fixed at each end of the frame, for attaching the sledges conveying the goods, &c., in a similar manner to the waggons of a railway train. On the arrival of the engine at Moscow, it is intended to fix at each end of the engine a house, of light but warm construction, as a protection for the engine-driver and conductor from the effects of the severe temperature. All parts of the radiating surfaces, steam pipes, &c., will be also thickly clothed with suitable non-conducting material. With a view to combine the maximum of strength with the minimum of weight, the machine has been constructed without the use of cast iron, excepting for the cylinders, wheel centres, and eccentric sheaves, the remainder of the work being wholly of wrought iron and gun metal.

Should the present engine prove moderately successful, it is the intention of the designer to construct a still more powerful engine, having a pair of wheels of larger diameter at the back of the fire-box, and the cylinder in front of the engine, which will be supported upon a single pair of guiding sledges, it having been found in practise that the six points of support are difficult of management in the event of the wheels getting into a hole or on a ridge of ice.

Some preliminary trials of the engine have been made upon the ice between St. Petersburgh and Cronstadt, the results of which have been on the whole satisfactory—a run of seven miles out and home having been obtained. Considerable difficulties were met with (as was to be expected) in the first starting of the machine, the excessively low temperature converting all water about the engine into solid ice. Filling up the feed-pumps, even when in steam, were amongst some of the inconveniences to which the experiments were exposed. Some idea may be formed of the intensity of the cold, when it is mentioned that the exhaust steam fell from the chimney top in a shower of snow.

THE BOOK TRADE.

The annual statement of the Board of Trade shows that in the year 1859, 6,520 cwt. of books were imported into this country from abroad—for at our Custom-house books are weighed, not numbered—and 33,543 cwt. of our books, of the declared value of £478,198, were exported from this country, besides 372 cwt. of foreign books, of the declared value of £5,201. Our exports, therefore, were five times as large as our imports. Of the books imported a third came from France; of the books exported a third went to the United States; a still larger proportion to our colonies; only 537 cwt. to France. The duty on the books imported (valued at £14 a cwt.) amounted to £5,295; but the duty then was 30s. a cwt., except on books of and from our colonies, or admitted under treaties of international copyright, both of which latter classes paid and pay only 15s.; but by Mr. Gladstone's tariff of 1860 the duty on unprivileged books imported from abroad, in all languages, is now reduced from 30s. to 16s. a cwt. Old books, printed before 1801, come in free of duty.

ROCK OIL.

The following letter has been addressed to the editor of the *Times*:—

SIR,—In November, 1859, in the State of Pennsylvania, wells were sunk for the purpose of pumping petroleum, or rock oil, and it has been vigorously continued up to this time, many of the wells producing from 10 to 50 barrels of oil a-day, and some even more.

In July, 1860, in the State of Ohio, 50 miles from this city, oil was discovered, and in the short time elapsed more than 50 wells have been put in successful operation, yielding from 10 to 60 barrels, and at this time hundreds of wells are being put down.

This oil is being refined for illuminating purposes, for which it is excellent, surpassing in brilliancy the best sperm oil, or any other article for light known on this continent, at the same time being half the price of sperm.

The oil, in a crude state, is an excellent lubricator, and many of our railroads use it, as well as other departments requiring a friction oil. The production bids fair to be very great, but the demand exceeds the supply, and the amount of money invested is now large, and is being increased daily. I notice in Sir Charles Lyell's *Principles of Geology*, 248 and 250, that the petroleum springs are mentioned, the most important of which are found in the Burman empire, near the city of Ava, a fact but little known, except to geologists and scientific men, and the simple announcement made and the reference* leave an anxious inquiry in the minds of inquiring men.

From the quantity spoken of there—viz., 400,000 hhds., it is inferred that it is appropriated to a good use, and that it is valuable as an article of commerce.

Can you, through your wide-spread journal, give in brief the origin, character, and uses of the Burman oil, how procured, quantity, and its utility as an article of use and its importance in commerce?

I will, at some future time, give you a fuller and more extended description of this branch of our commerce, and other matters of interest relating to its production, use, and probable adaptation to the wants of man.

Truly yours, HORACE WILKINS.

Cleveland, Ohio, Jan. 1.

Home Correspondence.

ADULTERATION OF FOOD.

SIR,—In the course of the discussion on Wednesday evening, after Mr. Scott had delivered his valuable paper on the adulteration of food, Dr. Riddell is reported to have said, "with regard to cayenne pepper, the public taste was in favour of a red-coloured article, although it was difficult to conceive how a genuine pepper of that colour could be furnished from a dark brown, or yellow chili." From this observation I am led to infer that Dr. Riddell is of opinion that genuine cayenne pepper ought to be brown or yellow, and that the red colour is imparted to it by the addition of brick dust, red lead, or some other deleterious substance, in deference to the public taste. If I am right in supposing this to be his opinion, I beg respectfully to inform him that he is labouring under a mistake; genuine cayenne pepper ought to be neither brown nor yellow, but red; and not red from the addition of brick dust, or any other foreign material,—but from the natural colour of the substance of which it is made. There is a great variety of capsicums, or chili peppers,—some large, some small,—some green, some yellow,—and some red. The best is that which is the most pungent, and the most aromatic, which is the small bird pepper. This pepper, when ripe, is in colour a bright vermilion,

* *Syme's Embassy to Ava*, vol. ii.; *Geol. Trans.*, second series, part iii., page 788.

and resembles in size and shape the seed of the hawthorn. The best cayenne pepper, both as regards flavour and pungency, is made of the bird pepper when it is perfectly ripe. It is in colour a light red. It would be a darker red if the husk or rind were only used; but the seeds being ground up along with it—and they are the most pungent part—and those seeds being yellow, the powder is not nearly of so brilliant a red as the integument of the fruit. I send you, for the inspection of Dr. Riddell, a small bottle of genuine cayenne pepper, and I assure that gentleman that it contains neither brick dust, red lead, nor any other foreign material whatever,—but is solely and exclusively pulverised bird peppers, gathered when ripe, and dried in the sun. If peppers are dried in an oven, as they sometimes are, they lose their aroma, and their colour is impaired. Very frequently cayenne pepper is made of green, unripe capsicums. I need not say that such pepper is very inferior in pungency and flavour. I know as a fact, that the greater part of the Jamaica cayenne pepper is adulterated, not here, but in the island itself. It is made of all kinds of capsicums, large and small, ripe and unripe. Its colour is generally a dirty drab, but a fine crimson hue is given to it by the addition of the farinaceous covering of the seed, and the pollen of the flower of the annotta (*Bixa Orellana*). This also adds to its substance. But cayenne pepper adulterated with the farina of the annotta, will not keep long, for the flour becomes sour and musty, and is liable to cake if it becomes damp.

In reading the remarks made by the various speakers who took a part in the discussion on Wednesday evening, I was, I confess, surprised at the dissatisfaction expressed by some of them at the statements of Mr. Scott, and I was still more surprised at the observations of the chairman, who characterised those statements as exaggerations. Mr. Scott is worthy of all praise for exposing the tricks of fraudulent traders, who, to enhance their own profits, do not scruple to administer poison by wholesale to the people. From the style in which some of the speakers aminadverted upon his revelations, one would suppose that the adulteration of food was a new question, that Mr. Scott had preferred charges before unheard of, and that the persons whom he denounced were much injured individuals, quite incapable of committing the acts which he attributed to them. But this is no new question. The charges are not now brought for the first time. Not many months ago a Committee of the House of Commons made a searching inquiry into this very subject, and they recorded a mass of evidence which more than confirmed all that Mr. Scott stated in his able and valuable paper. That committee elicited facts which made one's hair stand up on end, and one's blood run cold. Those facts convinced us, to our horror, that not a banquet did we sit down to which Cæsar Borgia might not have prepared; that not a festive board was spread, which did not—*ab ovo usque ad mala*,—support viands mixed with poisonous ingredients.

Nearly a hundred years ago the extensive adulteration of food, the unwholesomeness of the London water, and the filthy practices of the metropolitan dealers, were brought under the notice of the public by Dr. Smollett, a man of wit and imagination—but a man also of great learning and observation. He delivers himself through the medium of one of his own characters—Matthew Bramble, of Brambleton Hall. The sturdy and choleric Welshman expresses himself with much bitterness, but with not less truth. Speaking of the London water, he says: "If I would drink water, I must quaff the mawkish contents of an open aqueduct, exposed to all manner of defilement, or swallow that which comes down the Thames, impregnated with the filth of London and Westminster. Human excrement is the least offensive part of the concrete, which is composed of all the drugs, minerals, and poisons, used in mechanics and manufactures, enriched with the putrifying carcases of beasts and men, and mixed with the scourings of all the wash-tubs, kennels, and common sewers within the bills of mortality." Speaking of wine, he says:—"As to the intoxicating potion sold for wine, it is a vile, unpalatable, and pernicious sophistication, balderdashed with cyder, corn spirit, and the juice of sloes. In an action at law against a carman for having staved a cask of port, it appeared from the evidence of the cooper, that there were not above five gallons of real wine in the whole pipe, which held above a hundred,—and even that had been brewed and adulterated by the merchant at Oporto." Of bread, "the bread I eat in London is a deleterious paste, mixed up with chalk, alum, and bone ashes, insipid to the taste, and destructive to the constitution." Of veal, "the same monstrous depravity appears in their veal, which is bleached by repeated bleeding, and other villanous arts, till there is not a drop of juice left in the body, and the poor animal is paralytic before it dies, so void of all taste, nourishment, and flavour, that a man might dine as comfortably on a white fricassee of kid skin gloves, or chip hats from Leghorn." Of vegetables, "perhaps you will hardly believe that they can be so mad as to boil their greens with brass halfpence, so as to improve their colour, and yet nothing is more true." Of pork and poultry—"As for the pork, it is an abominable carnivorous animal, fed with horse-flesh and distillers' grains; and the poultry is all rotten, in consequence of a fever occasioned by the infamous practice of sewing up the gut, that they may be the sooner fattened in coops, in consequence of this cruel retention." Of oysters—"The right Colchester are kept in stone pots, occasionally overflowed by the sea, and the green colour so much admired by the voluptuaries of this metropolis, is occasioned by the vitriolic scum which rises on the surface of the stagnant and stinking water." Of fruit—"It was but yesterday I saw a dirty barrow huxter in the street, cleaning her dusty fruit with her own spittle, and who knows but some fine lady in St. James's parish might admit into her delicate mouth those very cherries which had been rolled and moistened between the filthy, and perhaps ulcerated chops of a St. Giles's huckster." I will conclude with his description of milk—"But the milk should not pass unanalysed; the produce of faded cabbage leaves and sour draff, lowered with hot water, frothed with brewed snails, carried through the streets in open pails, exposed to foul rinsings discharged from doors and windows, spittle, tobacco quids from foot passengers, overflowings from mud-carts, spatterings from coachwheels, dirt and trash chucked into it by roguish boys for the joke's sake, the spewings of infants who have slobbered in the tin measure, which is thrown back in that condition among the milk for the benefit of the next consumer; and, finally, the vermin that drops from the rags of the nasty drab that vends this precious mixture, under the respectable denomination of milkmaid."

These are not very savoury descriptions of the articles of common consumption in the days of Smollet; and if they be correct, we cannot wonder at the Welsh Squire pining for his goat's whey, and his mountain mutton. Whether such abominable practices as those above mentioned are now in vogue, I am not able to determine; but we have it on incontestable evidence, that there is scarcely an article of diet at the present time, which is not more or less poisoned; and I feel assured that at whatever table we may choose to dine, drink tea, or sup—unless we are prepared like Mithridates, King of Pontus, by being accustomed to every description of poison, so that none can take effect upon us—we drive a nail into our coffin by every morsel we eat, and we take a shovelful of earth out of our grave by every drop we drink.

I am, &c.,
R. TEMPLE.

SIR,—The subject of the adulteration of common articles of consumption seems to me so important, that the Council of the Society of Arts ought immediately to take some steps to meet the evil, and I would beg leave to suggest the easiest mode of doing so.

Let some person be engaged—no better man than Mr. W. L. Scott could be chosen—to write a small treatise, pointing out the most usual and important sophistications and the readiest mode of detecting them. The subject need not be farther extended than to the adulteration of bread, milk, butter, tea, coffee, pepper, pickles, preserved fruits, sugar, sweetmeats, and vinegar; and also some simple tests should be described for discovering copper, lead, arsenic, and sulphuric acid in any article. At the same time there should be published a box containing suitable tests and apparatus for performing the required analyses. The treatise ought not to exceed 1s. in price, and the box of tests £1. Of course, analyses so performed by unaccustomed hands could only give a rough result, insufficient to convict a tradesman; but when a buyer has thus convinced himself of the adulteration of any article, he could either pursue the subject further, by taking it to a professed analyst, and so obtain legal evidence of the sophistication, or change his tradesman till he finds the vendor of a pure article. Many adulterations are so easily discovered by very ordinary skill, that, with the assistance I have suggested, I make no doubt that many persons would be able to perform the necessary analyses, and possibly, remonstrance with the vendors might often be sufficient to remedy the evil.

Having been engaged several years in the administration of the Poor Laws and in visiting pauper schools, my attention has been frequently called to the adulterated articles furnished to the poor in workhouses. I have often remarked the superior health of the children in those pauper schools where cows are kept and bread is made in the house, *i.e.*, as I infer, where the children are fed with these important ingredients of their dietary in a pure state.

I think there can be no doubt that such a pamphlet and box of tests as I have suggested would meet with an enormous sale. I am, &c.,

E. CARLETON TUFNELL.

SIR,—I wish to say a few words on the adulteration of green tea, cocoa, and milk.

A patient of mine finds green tea the best remedy for occasional nervous headaches, but in searching for green tea, out of some ten shops, where he purchased samples, he found only one genuine. The proof was a very simple one. In nine of the cases the green colour was washed off by the infusion; in one only the leaves remained of a greenish hue after the infusion.

What is called "Homœopathic Cocoa" is a very inferior article to that sold ten years ago. Most samples of this cocoa are now adulterated with probably not less than from 30 to 50 per cent. of farinaceous materials. Genuine cocoa is only to be had by those who purchase the nibs. From the recent excellent papers on cocoa which appeared in your journal, it seems that the best cocoa never comes to this country. I have very great faith in cocoa as an article of diet, and I believe it has never been fully appreciated in this country; and I feel convinced that if any one with capital and energy entered upon the wholesale and retail business of cocoa seller, he would, if he acted with perfect honesty, and supplied the public with only the very best cocoa, realise in London a large fortune.

Water is almost the only adulteration of milk, and is easily detected, thus:—Get a "test tube," about 10 inches long, fill it with milk, and let it stand for 36 hours. If there is water present it will all sink to the bottom of the test tube. The cream will float on the top, and in 10 inches of good milk there shoud be about one inch of cream. Ten quarts of milk produce one quart of cream. This is sold for 4s.; the remaining skim-milk is sold to small dealers at 2d. a quart; this is, in poor districts, diluted with water, and sold to the poor for 3d. a quart! Almost all the milk supplied to London is produced by cows kept in stables in town, and consumption is a common disease with such cows.

Finally, if legislation is required with regard to the supply and quality of our food, no branch of food industry requires it more than the milk trade, as milk is the most universally used, and the most universally applicable from infancy to old age, of all kinds of food.

I am, &c.,

GEO. WYLD, M.D.

TEA.

SIR,—I have read with much pleasure the interesting paper by Mr. L. Wray, and think the time very opportune for directing public attention to so large an article of consumption as tea; there can be no possible doubt that the tea which reaches this country has by no means the aroma and fragrance of the tea used in China, as well as in Russia.

The Russians boast of the good tea they get, although they certainly pay a much higher price for theirs than we pay for the usual tea sold retail to consumers here in England; the tea that reaches St. Petersburg is brought from China overland, or by the excellent Russian system of river navigation, and seems to retain its peculiar perfume and taste to a high degree. It is said that the cause of the flatness and small perfume of the teas used in England, is accounted for by the long sea-voyage it endures, and that the mode of packing is not effectual in retaining the most refreshing qualities of the tea. On entering a room in Russia where tea is being made, one is met by a light, fragrant, aromatic perfume, that is most refreshing; the infusion (generally drunk with sugar and a slice of lemon, without milk) is also invigorating and comforting to the system. The English little know the pleasure they lose in the flat, insipid tea they generally drink, and, could they but taste it in its perfection of flavour, would soon set aside such teas as have lately been forced into consumption.

The Russians are as particular in their teas as we are in our wines, and will give an extravagant price for a really fine specimen. I was offered tea, at a beautiful establishment in Moscow, at 50s. per pound, and so much is it cared for, that elegant and costly silk and satin covered boxes are prepared to contain choice sorts, as presents for friends. I am, &c.,

G. N. H.

SIR,—On the misunderstood, and consequently misrepresented subject of tea adulterations, allow me to offer a few remarks. They shall be as condensed as possible. Being myself quite certain that but a very small proportion of the teas imported into this country are in any way adulterated, I desire, through the medium of your valuable journal, to lay before the public, as simply and briefly as may be, a few of the many facts which might be advanced, and which may, perhaps, best illustrate the grounds of my own conviction in this matter. As I wish to address solely the uninitiated but vitally interested consumers of the article in question, I will endeavour to avoid all Chinese and scientific technicalities, and speak merely from careful observation and long practical experience in the English markets. What I would show, then, is that tea not only is not, but cannot be, adulterated, supposing the commercial principle to rule, viz.,—"that the object of production is profit."

To meet any queries and doubts that already exist or may arise, it may at once be admitted that there have been and are small consignments which may be truly called adulterated or imitation teas occasionally arriving from Canton. These consist of such rubbish as may become mixed with the sweepings of the Canton packing warehouses; certain and sundry teas, damaged during land or junk transit in China, &c., together with such odds and ends as accumulate from time to time at the said port, and are there broken down by mills into dust; rolled into large shot-like particles, by means of a preparation of gum or starch, and coloured and scented as

either Canton gunpowders or capers; but these occasional adaptations and imitations, however, only serve to prove the result of a false economy, wrongly based on the maxim of gathering up the fragments; since such consignments have seldom if ever paid, when brought here, the bare expenses of manufacture and transit. The same has been the ultimate fate of all other grades, of whatever kinds, which have really been of the class of spurious sorts, as on such parcels, even when they have sold at a profit on first arrival, profit has never resulted to the purchaser, but invariably a fearful loss. No sort of leaf is so abundant in the tea districts of China as the leaf of the genuine tea plant, and as any other leaf (even there, where the means of manufacture are at hand) would entail as much or more trouble and expense in the gathering and preparation, where or in what can exist the motive for substitution? I altogether pass over the absurd supposition that tea leaves already infused are collected and re-dried; the process of collection, purification from consequent mustiness, &c., and re-manipulation, would be more difficult and expensive than the preparation and first cost in China of the finest crop of tea ever produced. For these simple reasons I would therefore humbly submit that teas as imported are not open to the charge or suspicion of having been largely adulterated.

On the second point it is not attempted to be denied that the different grades of tea are mixed together in China at the packing ports to make up chops* for price, but this practice requires great experience and care on the part of the blenders. Teas of a similar leaf and class, though perhaps a lower grade in quality, can only be so mixed, inasmuch as really common congou mixed with the finer kinds in any proportion would lower the quality, and consequently the money value of a chop of good or fine tea many pence per lb.; much less, then, can any spurious substance be so used with impunity. As well might the wine importer make the insane attempt to reduce the cost of his wines by the admixture of water. Tea, however, in this particular is much more sensitive than wine.

The following instances in my own knowledge will illustrate this point, as serving to show that the manipulated leaf is so exceedingly susceptible of the least taint or contamination that it cannot be profitably tampered with:—A parcel of "Fine oolong" (about 200 half-chests) was placed in a London bonded warehouse. From its superior quality it was very soon purchased by a London wholesale dealer, who, on account of the good condition of the packages, ordered them not to be inspected†; the leads of only a few sampled ones were therefore cut. After a very short time (warm weather setting in), on drawing trade samples something peculiar was detected in this parcel of tea; the quality being superfine and the price high, the sales and clearances were slow. At length positive complaints came from the dealers who had the most recently had packages of the said tea out of bond; the tea was right in class and leaf, according to the first-drawn samples, and the packages in the best condition (*i.e.* not sea-damaged or otherwise injured), but something was now the matter with this tea which nobody could understand. On arriving at this conclusion the packages remaining in bond were laid down for inspection, and on cutting the leads, one single half-chest which, on the first removal from the ship had been placed somewhere about the middle of the stack pile of the 200 packages, was found to contain the remains of three or four Chinese mice, which had been in a state of putrefaction, the effect of which seemingly trifling circumstance I have already detailed.

Again, some three or four seasons since, a similar series of circumstances, as to quality, condition, and subsequent complaints happened to a chop of the finest Kaisow congou. In this instance the whole of the tea had been carefully inspected immediately on its arrival, and passed as in perfect condition, except from sea damages, &c. This tea, being new season's, of the finest quality, was at once in general demand, and a great many chests were quickly cleared for consumption, the recipients widely differing in their opinions;—praises and condemnations, good orders and countermands, arriving with contradicting perplexity from town dealers and from all parts of the country. In this case, after a more minute examination of tea and package chest by chest, it was discovered that about one-sixth of this chop was packed in chests partly made of "Sassafras wood," and although some of such packages contained only a strip of the said wood, yet all the tea in every such chest was so impregnated with the peculiar spicy scent of that most aromatic shrub, that not only was the decoction from this thus tainted tea peculiar in flavour, but almost undrinkable. Had this accident of wrong wood having been used by the package-makers in China, remained long undiscovered, the whole of this valuable chop of tea would have become comparatively worthless, as some of the packages not actually containing any of the objectionable wood had already imbibed the contagion.

It may here occur to the thoughts of some who are unacquainted with the peculiar property of tea to so readily absorb any foreign odour, that the two cases mentioned apply to the finest and consequently to the most delicate descriptions only, but the concluding fact, which I beg to cite, will, it is hoped, fully answer any such query.

A very mixed cargo or consignment of teas consisting of all grades, from low to medium and fine, was some years since deposited in a bonded warehouse at Hull; and every pound of every chest that remained there for any number of weeks became strongly tainted with the flavour of oranges, quantities of which were stored in the floors below. Moreover it may here be added that drug and even sugar ships are useless in the China ports for tea shipments, as all such vessels would do great damage to a cargo of tea.

Official statistics, &c., I must altogether omit, or I fear too much of your space would be taken up; these with hints to the consumer, &c., shall follow if needs be. What I now have endeavoured to impress on the public mind is,—that tea as an article of commerce is, in all its grades of quality and modes of preparation, so susceptible of the slightest contamination, that it cannot be adulterated with impunity and profit; that it is in fact the "true sensitive plant," and will (so long as it remains a daily necessity of our nation) be its own exciseman.—I am, &c.,

W. G. REYNOLDS.

Feb. 2, 1861.

* A chop of tea means all there is of the particular parcel (for the shipment or season) of that particular make and quality, and consists of black teas, say 600 chests, and of green teas from 30 to 300 half-chests.

† Every package of the different chops is generally inspected on arrival, and as a further proof of the great vigilance exercised by the hands through which they pass in China, it is but seldom that any even trifling variations occur in the quality of even the largest chops.

Proceedings of Institutions.

BROMPTON (NEAR CHATHAM) CHURCH OF ENGLAND YOUNG MEN'S SOCIETY.—The tenth annual report speaks of the success of the Institution during the past year. During the session, lectures were delivered as follows:—B. Shaw, Esq., late Fellow of Trinity College, Cambridge, "A Suit in Chancery;" Captain Scott, R.E., "The Dial Plate of the Heavens;" Captain Scott, R.E., "The Chemistry of the Kitchen;" the Rev. H. Gurney, "Proverbs—their Wit and Wisdom;" J. Defraine, Esq., "How to get on in the World;" J. Defraine, Esq., "Our Young Men and Women;" J. Anderson, Esq., "The Properties of the Atmosphere;" Lieut.-Col. Rowlandson, "India, and the Sepoy Mutiny;" the Rev. J. B. Owen, "Old-School Affectations in Literature, &c.;" the Rev. R. Maguire, "The Construction of a Watch;" and Capt. Scott, R.N., "Recollections of the South Seas." The expenses

necessarily incurred in providing these lectures exceeded the receipts; indeed, the pecuniary returns on these occasions are stated to be very uncertain. The Monday evening meetings on Biblical and Secular subjects continue to be appreciated. The results of the Examination of the Society of Arts, in May last, were highly satisfactory—six of the members having obtained certificates. What has been achieved on this first effort will, it is hoped, stimulate the successful candidates to greater exertion, and also encourage others to present themselves at the Examination of 1861. The thanks of the Committee are due to those gentlemen who constitute the "Local Board," for their valuable aid in conducting the "Preliminary Examinations," and in carrying out the regulations of the Society at the "Final Examination." The Committee gratefully acknowledge the valuable services of those gentlemen who have kindly lectured gratuitously during the past year. The Serial department of the Society continues to fulfil its mission, by supplying weekly, at the homes of the members, the best periodicals of the day—no less than 5,980 changes having been made during the year. The library now numbers 600 volumes. The Committee wish to record their grateful sense of the untiring zeal evinced by the late Honorary Secretary, Mr. J. Newlyn, in the cause of the Society. The income of the Society during the past year has been £83 15s. 7d.; the expenditure, £83 13s. 11d., leaving a balance in the treasurer's hands of 1s. 8d.

CARLISLE, CHURCH OF ENGLAND INSTITUTION.—The first lecture of the season, in connection with this Association, was delivered on the 30th October last, in the Athenæum, by the Worshipful Chancellor Burton, President of the Association. G. H. Head, Esq., occupied the chair; and there were also on the platform the Venerable Archdeacon Jackson, Rev. W. Belt, &c. The Chancellor's subject was "Archbishop Cranmer."—A vote of thanks was accorded to the Chancellor, who, in reply, said he was at all times willing to do whatever lay in his power for the benefit of the Institution. The CHAIRMAN alluded to the various excellent features which distinguished the Institution—a valuable library, a reading room, and classes in which different branches of learning were taught gratuitously by competent masters. They were also in union with the Society of Arts; and a number of their young people had taken part in the examination of that Society held in May last—the result being, he was delighted to say, that out of 14 competitors, no fewer than 11 had obtained certificates—and these certificates he would now present to the young gentlemen who had won them.—The Chairman then called upon each of the prizemen separately and presented him with his certificate. In conclusion he said that the duty he had discharged was a pleasing one to him. It was a good sign of the times, and he hoped the young men would continue to pursue their studies with energy and vigour. Their knowledge would promote their comfort and happiness in passing through life—it would enable them better to discharge their duties to themselves and to society—and would tend to make the evening of their life calm and peaceful. He wished them God speed in their onward course.—A vote of thanks was passed to the gentlemen who conduct the classes.—The Rev. W. BELL, chairman of the committee who preside over the classes, responded. His own class was one of the smallest, but the subject, Latin and Roman history, was not so popular as some others. However, he was happy to say that his class—and, indeed, all the classes—had very considerably increased in numbers; and from what had been done during the late year to further the work of education by means of these classes, they had every reason to look forward to next year for still better results. For his own part he should be extremely happy—and he could speak as confidently for the other gentlemen—to give his very best efforts towards forwarding that work, which was, to his mind, so intimately associated with the prosperity of the Institution. A vote of thanks to the Chairman brought the proceedings to a close.

LOCKWOOD, MECHANICS' INSTITUTE.—The annual meeting was held on the 30th of January, Mr. Chas. Kaye in the chair. He said he was glad to meet the members once more, and to see such a good attendance. He regretted that they had not a new Mechanics' Hall to meet in, as had been anticipated, but this was not the fault of the committee, who had taken the necessary preliminaries in the matter, but it was owing to the difficulties met with by the collectors amongst those who had been solicited for subscriptions. He believed these difficulties would speedily be removed, and he hoped to see, before another year, a building suitable for a Mechanics' Institution. He then called upon Mr. Lee, the secretary, to read the report, from which it appeared that the number of male members was 169, besides 50 female members. The library contained 585 volumes, 50 having been added during the past year, and the issue had been 1917, about the same number as the previous year. The cash account showed that the receipts during the year had been £133 15s. 9d., and the balance at the commencement of the year was £4 8s. 9d., making a total of £138 4s. 6d. The expenditure had been £135 8s. 5½d., and the balance in the treasurer's hands was £2 16s. 0½d. The following gentlemen were elected to serve on the committee for 1861:—Captain Bentley Shaw, President; Mr. Spencer Beaumont, Treasurer; Rev. T. B. Bensted, M.A., Rev. Jno. Barker, Messrs. T. Haigh, J. Brierley, J. Kettlewell, S. Lodge, J. M. Spedding, J. Kenworthy, S. Ogden, F. W. Armitage, S. Black, H. Taylor, C. Kaye, B. Armitage, J. Dow, T. Tate, N. Berry, and J. Smart.

PORTSEA, WATT INSTITUTE.—On Monday evening, the 14th instant, the annual *soirée* in connexion with this Institution took place at the Queen's Rooms, Lion-terrace, and the promises held out by the Committee were more than realised. A. Murray, Esq., the President of the Watt Institute, occupied the chair. The platform was most tastefully decorated, and the room was crowded to excess. Mrs. Donnison (teacher of music) kindly presided at the pianoforte, and performed various selections of music. She was accompanied in several of the pieces by Mr. Coller, on the flute. The vocal department was sustained by Miss Nowell, Mr. Budden, Mr. Madge, and Mr. Croxall and Mrs. Donnison. The band performed at intervals during the evening. Refreshments were supplied on the most liberal scale. Several recitations were well given, especially one by Mr. Caldwell—"Eugene Aram's Dream." The entertainment concluded with the amusing dialogue of "Box and Cox," the character of Cox being sustained by Mr. Barnes. A vote of thanks was passed to the Committee for their successful exertions, as also to Mr. Murray for presiding.

MEETINGS FOR THE ENSUING WEEK.

MON. ...Discussion on the Papers read at the last Meeting, viz.:—
1. "The North Atlantic Telegraph," by Capt. Sir F. L. McClintock and Allen Young, Dr. Rae, Mr. Tayler, and Col. Shaffner. 2. Mr. Macdouall Stuart, "Further details relative to the discoveries in Central Australia."
Medical, 8½.

TUES. ...Syro-Egyptian 7½. Rev. John Mills, "Account of a recent visit made to Mounts Gerizim and Ebal."
Civil Engineers, 8. Continued discussion upon Mr. Braithwaite's paper "On the River Wandle."
Medical and Chirurg., 8½.
Zoological, 9.

WED. ...Literary Fund, 3.
Society of Arts, 8. Dr. Edward Smith, "On the Uses of Tea in the Animal Economy."
Graphic, 8.
Microscopical, 8. Anniversary.
Roy. Soc. Literature, 8½.
Archæological Assoc., 8½.

THURS...Royal Soc. Club, 6.
Philological, 8.
Royal, 8½.
Antiquaries, 8½.

FRI. .....London Inst., 1. Anniversary.
Royal Inst., 8.

SAT. .....Asiatic, 3. Mr. Redhouse, "On the Turkish Bath, and the characteristics which distinguish it from the Roman Bath."

PATENT LAW AMENDMENT ACT.

[*From Gazette, February 1st*, 1861.]

Dated 5th November, 1860.

2708. E. F. Prentiss, Philadelphia, U.S.—A new detergent.

Dated 24th November, 1860.

2809. S. M. Fox, New York, U.S.—Imp. in rails for railways, and in the wheels to run thereon, especially adapted to street railways.

Dated 10th December, 1860.

3031. W. E. Newton, 66, Chancery-lane—Imp. in machinery for "quartering" cork-wood, and for cutting the quarters into bottle corks. (A com.)

Dated 3rd January, 1861.

18. S. Perkes, Clapham, Surrey—Imp. in presses and modes of pressing, applicable to cotton, hemp, wool, coir, hides, hay, fibres, peat, linen, thread, piece goods, extracting oil, and other useful purposes.

Dated 8th January, 1861.

46. W. Rattray, Aberdeen—Imp. in preserving organic substances.

Dated 11th January, 1861.

72. H. T. Hooper, Killiow Kea, Truro, and W. Gerrans, Tregony, Cornwall—An improved machine for distributing manure on lands.

74. W. H. Muntz, Millbrook, Hants—Imp. in breaks for locomotive engines.

80. W. H. Moran, Cologne—Imp. in gas meters.

82. A. Rêne le Mire Normandy, Odin-lodge, King's-road, Clapham-park—Imp. in connecting gas and other pipes.

86. R. Smellie, West Merrieston, Lanark, N.B.—Imp. in apparatus for supporting and working sash windows and other similar sliding or traversing details.

Dated 12th January, 1861.

88. W. Bullough, Blackburn—Imp. in looms for weaving.

94. H. Matheson, Lahore-terrace, Sydenham-road, Croydon, Surrey—Improved apparatus for generating steam.

Dated 14th January, 1861.

100. J. Baldwin, jun., and J. Crossley, Halifax—Imp. in machinery for combing wool or other fibrous substances.

102. W. Desilva and T. F. Griffith, Liverpool—An improved construction of instrument for taking observations at sea or on land.

104. J. Horsey, Belvedere-road, Lambeth, Surrey—Imp. in pouches or receptacles for tobacco and other articles.

106. J. Lark, Canal-house, Strood, Kent—Imp. in the manufacture of Portland cement.

Dated 15th January, 1861.

110. J. Willcock, 89, Chancery-lane—Imp. in gas regulators. (A com.)

114. R. Wilson, Patricoft, Lancashire—Imp. in screw propellers, and in machinery or apparatus for actuating the same.

118. A. V. Newton, 66, Chancery-lane—Imp. in the construction of railway and other carriages. (A com.)

120. J. Picken, Birmingham—Imp. in breach-loading fire-arms and ordnance.

122. H. Sagar, Broughton, Manchester—Imp. in machinery for finishing patent tracing cloth and woven fabrics.

Dated 16th January, 1861.

124. E. Whittaker and J. Clare, Hurst, Lancashire—Imp. in machinery or apparatus for preparing cotton or other fibrous materials to be spun.

126. J. W. Graham, Manchester—Certain imp. in machinery or apparatus for cutting, shaping, and dressing stone or other similar substances.

128. J. Telfer, Newcastle-upon-Tyne—Imp. in capstans and winches for hoisting, which improvements are also applicable to the steering of ships.

Dated 17th January, 1861.

130. W. Spence, 50, Chancery-lane—Imp. in machinery for making butt hinges. (A com.)

131. J. H. Craven, Keighley, Yorkshire—Imp. in spinning and doubling wool, cotton, silk, flax, and other fibrous substances, and in machinery or apparatus employed for the same.

132. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—Imp. in apparatus and materials for filtering water and other liquids. (A com.)

133. G. Lewingdon, Bridport, Dorsetshire—Imp. in chimney and ventilating cowls.

135. W. Clark, 53, Chancery-lane—Improved apparatus for raising fluids. (A com.)

136. E. Jullien, Marseilles, France—Imp. in machinery for preparing and treating hides and skins in the manufacture of leather.

137. M. Henry, 84, Fleet-street—Imp. in apparatus for locomotion, and in the construction of certain wheels employed therein, and of levels used therewith, such improved wheel and level being also applicable for other purposes. (A com.)

138. J. R. Joy, All Saints-street, Bristol—Imp. in machinery or apparatus for lithographic printing,

Dated 17th January, 1861.

139. J. Townsend and J. Walker, Glasgow—Imp. in mordanting, and in the manufacture of products to be used as mordants and otherwise.

140. E. Argent, White Lion-street, Pentonville—Improved apparatus for lifting and tilting casks, or other receptacles containing fluids.

141. I. Bates, Dukinfield, Cheshire—An imp. or imp. in apparatus for preparing warps for the loom.

142. R. Mason, Alford, Lincolnshire—Imp. in apparatus for washing and churning.

143. J. Jobson, Derby—Imp. in the manufacture of stove grates.

144. W. E. Newton, 66, Chancery-lane—An improved clutch apparatus for transmitting motion to various kinds of machinery. (A com.)

Dated 18th January, 1861.

145. B. Piffard, 17, Caroline-villas, Kentish Town—Imp. in the preparation of non-conducting substances, for the deposition thereon of metals by electric action.

147. W. A. Lyttle, 10, Arundel-street, Strand—Imp. in, and connected with, projectiles, to be used with ordnance, rifles, and other arms.

148. F. G. Sanders, Poole—Certain imp. in the construction of boxes for containing earth for growing shrubs or trees, which imp. are also for paving, flooring, building, and other purposes.

149. R. M. Latham, 71, Fleet-street—Imp. in the construction of children's rocking toys. (A com.)

150. J. Bond, Tom Law, near Darlington—Imp. in railway wheels.

151. H. Vandercruyce, Cours du Trente Juillet, No. 32, Bordeaux—Improved means or apparatus for lowering or striking the masts of ships at sea with sails and courses set.

152. C. W. Lancaster, New Bond-street, Middlesex, and J. Brown and J. Hughes, Newport, Monmouthshire—An imp. in constructing forts, screens, and other like defences.

153. J. B. Rickards, Snow-hill, London—Imp. in the construction of axle boxes for the wheels of vehicles used on railways, applicable also to the wheels of vehicles used on common roads, for the purposes of reducing friction. (A com.)

155. M. Henry, 84, Fleet-street—Imp. in machines for manufacturing corks, bungs, spiles, and such like articles. (A com.)

157. W. Clark, 53, Chancery lane—An improved device for balancing slide-valves of steam engines. (A com.)

Dated 21st January, 1861.

159. C. E. Albrecht, Radnor-place, Hyde-park—Imp. in instruments or apparatus for indicating or measuring the pressure of steam and other fluids.

161. Lieut. J. Scott—23, Michael's-place, Brompton—Imp. in rifles and their projectiles.

163. R. Mushet, Coleford, Gloucestershire—An imp. or imps. in the manufacture of cast steel.

165. T. Stewart, Northampton-street, Clerkenwell—Imp. in vehicles known as hansom cabs.

Dated 22nd January, 1861.

167. C. W. Siemens and F. Siemens, Great George-street, Westminster—Imp. in furnaces.

169. G. White, 7a, Pancras-lane—An improved warping and beaming mill. (A com.)

171. R. Philp and J. Philp, 9, Lower John-street, Golden-square, Middlesex—An imp. in propellers for propelling ships, boats, and other vessels in water.

173. R. Henderson, 15, Park-place, Bayswater-road—An improved "dumb-jockey" for breaking or training horses.

175. J. Chatterton, Highbury-terrace, and W. Smith, Pownall-road, Dalston, Middlesex—Imp. in the manufacture of telegraphic cables.

177. R. A. Brooman, 166, Fleet-street—An improved method of manufacturing tyres for wheels, hoops, and rings. (A com.)

PATENTS SEALED.

[*From Gazette, February 1st*, 1860.]

January 31st.

1686. J. Ferguson.
1866. A. F. Haas.
1878. F. X. Kukla.
1881. E. A. Count de Strada.
1889. R. Bodmer.
1899. H. de Mornay.
1913. J. Webster.
1919. J. Fielding, D. Whittaker, and B. Croasdale.
1946. J. Wilkins.
2108. W. E. Newton.
2212. J. Chesterton.
3599. E. Breffit.
2668. D. Joy.
2704. Sir P. Fairbairn, Knt., and R. Newton.
2874. B. Beniowski.
2946. H. Greaves.

PATENTS ON WHICH THE STAMP DUTY OF £50 HAS BEEN PAID.

[*From Gazette, January 30th*, 1861.]

January 28th.

151. C. N. Kottula.
165. R. Weare.
166. J. Wotherspoon.
176. P. Ashcroft.

January 30th.

186. W. J. Hay.

[*From Gazette, February 5th*, 1861.]

January 31st.

214. E. and T. Collingwood.

February 1st.

190. J. Sholl.
203. J. Harrison.
204. R. Harland.

February 2nd.

PATENTS ON WHICH THE STAMP DUTY OF £100 HAS BEEN PAID.

January 28th.

224. B. O'Neale Stratford.

January 30th.

234. L. Young and E. Marten.
259. J. Beattie.

[*From Gazette, February 5th*, 1861.]

February 1st.

261. A. Mohler.